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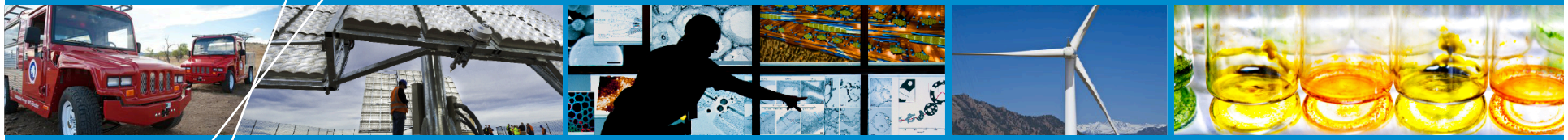
Regulatory Considerations Associated with the Expanded Adoption of Distributed Solar



Webinar February 20, 2014

Moderator Lori Bird (NREL)

Presenters Joyce McLaren (NREL)

Carl Linvill (RAP)

Webinar Logistics

- **Participants are joined in listen-only mode.**
- **Use the Q&A panel to ask questions during the webinar. We will hold all questions until the end of the webinar.**
  - **To ask a question:**
    - Click Q&A at the top of the Live Meeting Window
    - Type your question in the Q&A box
    - Click "Ask" to send question
- **The webinar is being recorded and a link will be sent to all online participants once it is available.**

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- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

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Agenda

- ✓ **Background**
  - What is the debate?
- ✓ **Utility Business Models**
  - How can utilities become involved in DG solar?

- ✓ **Costs and Benefits / Valuation**
  - How to determine the value of DG solar?
- ✓ **Rate Structures**
  - What rate structures support increased DG solar?

Background

What is the debate?

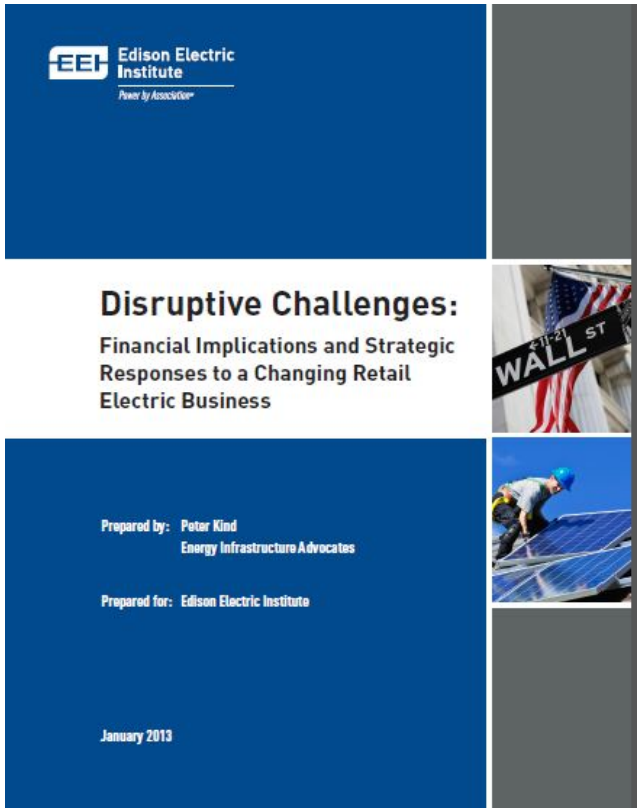
Which states have active discussion? On what topics?

Background on the Debate

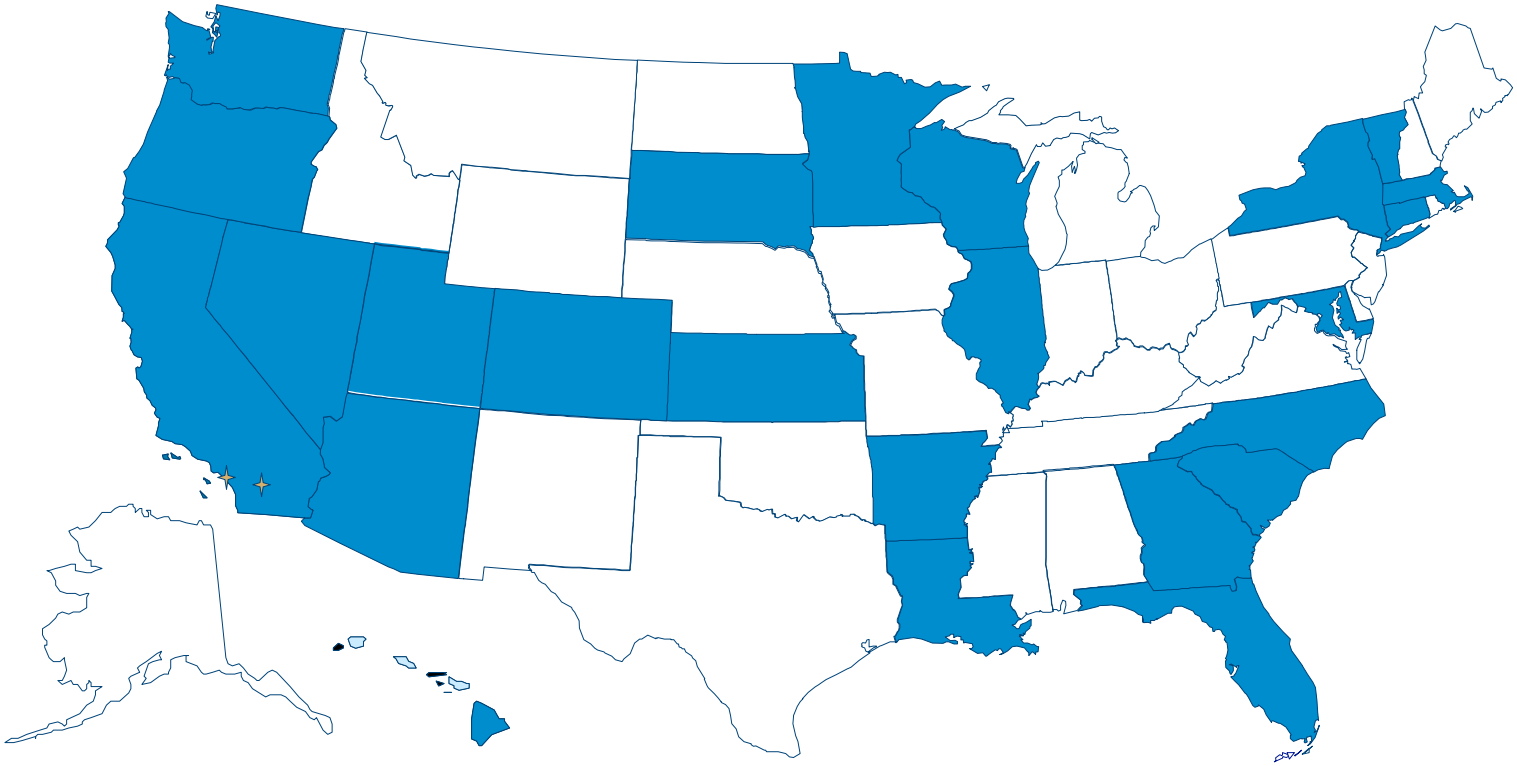
Rapid growth in distributed solar has led to increased attention

- Utilities concerned that:
  - DG reduces utility revenues and undermines traditional utility business models
  - the fixed cost of maintaining the grid is spread across fewer customers and fewer kWh sales
  - cost shifts are occurring between solar and non-solar customers

- Solar industry concerned that:
  - Policy and rate changes will under-value solar generation and hinder the solar market

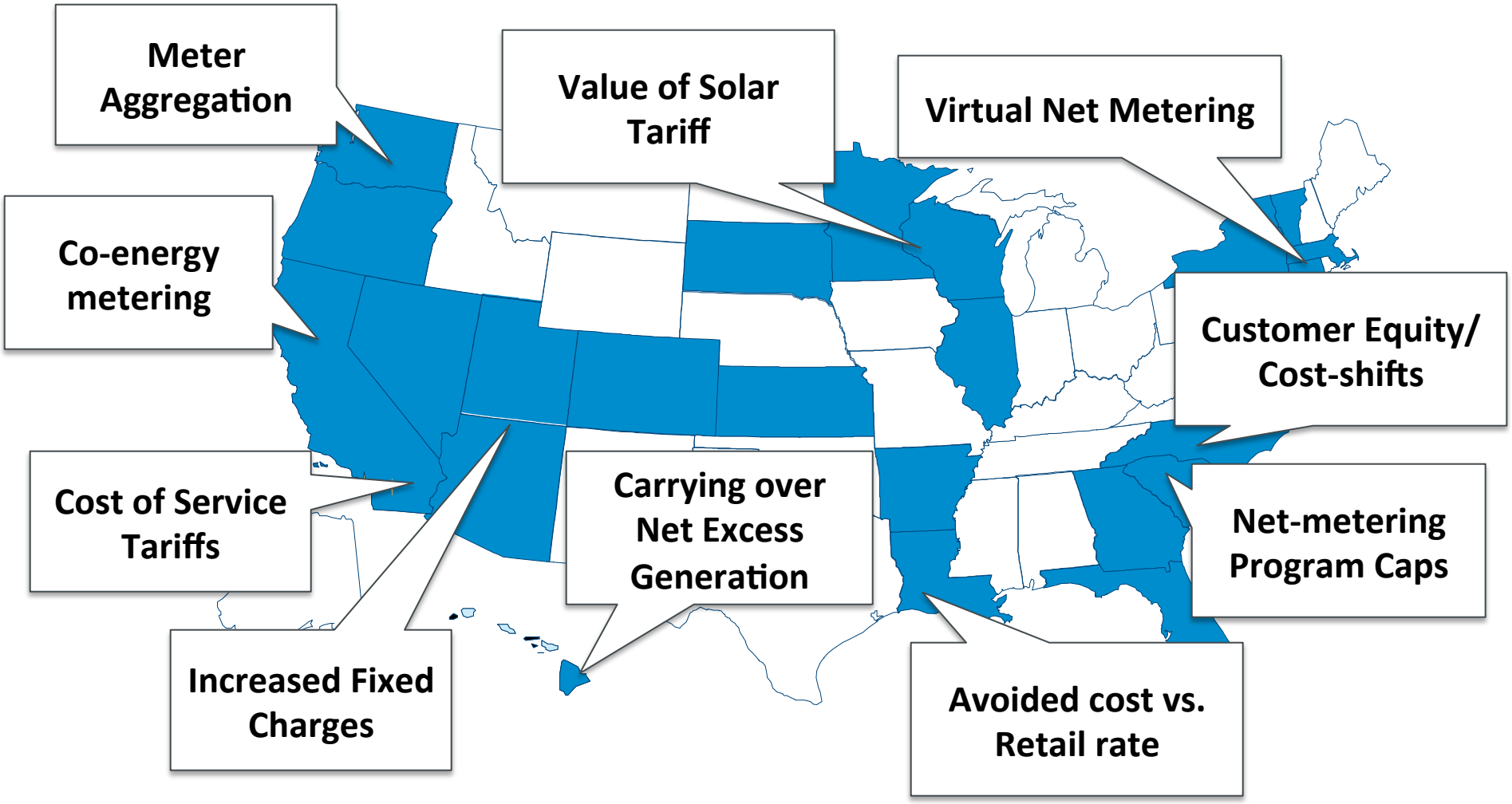


States with Active Discussions



Legislative or regulatory activity on net metering or value of solar

A Variety of Discussion Topics



A Variety of Discussion Topics

- **Net-metering**
  - What should the cap be?
  - What method should be used to calculate the installed capacity and the cap?
  - At what rate should net excess generation be credited?
  - Should excess generation carry over year-to-year or expire at the end of the year?
  - How can Time-of-Use rates be combined with net metering?
  - Is meter aggregation allowed/required?
  - Is Virtual Net Metering allowed/required?

- **Cost-shifts / Lost Revenue**
  - Is there a cost-shift from solar to non-solar customers? How large? How to address?
  - What is the impact of distributed PV on utility revenues?
  - Should fixed charges be increased to cover infrastructure costs? Should they apply to only self-generators or to all customers, with corresponding reduction in volumetric rates?
  - What other rate structures can address the cost-shift and lost revenue issue?

- **Value of Solar Tariff**
  - What variables should be included in a value of solar tariff?
  - What value should each cost and benefit be assigned?
  - How should a value of solar program be designed?

Business Models for Distributed Solar

What are the most common solar business models today?

How can utilities become more involved in distributed solar?

Business Models for Distributed Solar

Common Business Models

- **Customer-owned model**
- **3rd party leasing model**
- **Community and utility-led solar gardens**

Innovative Business Models

- **Utility-owned DG solar**
- **Virtual power plant operator**
- **Utility partnership/investment in 3rd party leasing companies**
- **Value added consulting services**
- **Energy services utility model**

New utility business models may address utility concerns about lost revenues/cost-shifts.

**See the full report for more description of each of these business model options.*

Community Solar / Solar Gardens

Customers pay an upfront fee or fixed monthly payment, which entitles them to a portion of the benefits of a specific solar project.

Variety of Leadership Options

Solar gardens are being initiated by community organizations, municipalities, and utilities across the country.

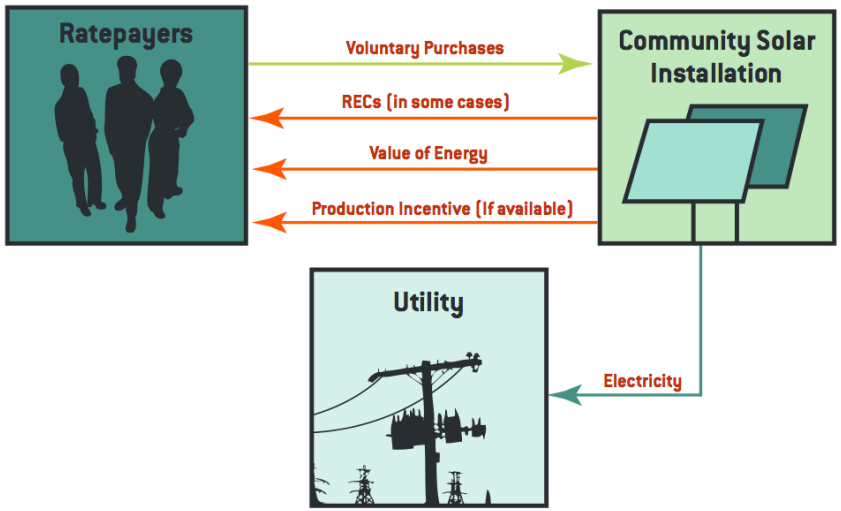
Variety of Location Options

Solar gardens can be built on brown-fields, public building rooftops, and on private or public land.

Community Solar / Solar Gardens

Benefits to Customers

- Expanded opportunities to participate in solar
- Increased rate stability
- Potential for bill savings
- Hedge against price increases



Benefits to Utility/Developer

- Customer satisfaction
- Customer engagement
- Regional economic development
- Lower incentive costs
- Meet RPS requirements
- Potential for distribution system benefits

Existing Community Solar Projects

Utility-led	Community-led
Tucson Electric (AZ)	City of Portland "Solar Forward" (OR)
Xcel Energy (CO)	Falmouth Community Solar, LLC (MA)
Delmarva Power & Light (DE)	Northern Sun Community Solar Garden (MN)
Green Mountain Power (VT)	Acorn Energy Solar One, LLC (VT)
SMUD Solar Shares (CA)	University Park Solar (D.C.)
Berea Solar Farm (KY)	Putney Community Solar Array (VT)
Florida Keys Electric Co-op (FL)	Winthrop Community Solar (WA)

http://www.sharedrenewables.org/

Community Solar Program Design Considerations

✓ Ownership Structure

- Privately-owned, Utility-owned, Third-Party Owned, Flip Structure

✓ Subscription Options

- Capacity-based – customers purchase the benefits of a certain amount of capacity (panels)
- Generation-based – customers purchase a certain number of kWh or a % of the system's generation

✓ Treatment of RECs

- Customer-retains, Utility-retains
- Are they retired?

✓ Securities Compliance

- Does the chosen program structure trigger securities issues?

✓ Eligibility for Incentives

- How can incentives be maximized?
- Are incentives considered taxable income?

✓ Pricing and Billing

What should you charge participants?

Administration + Marketing + Supply + Operation + Maintenance + Integration

= Total Cost ($) over 20 years

$$\frac{\text{Total Cost}}{\text{\# kW}} = \$ / \text{kW} \qquad \frac{\text{Total Cost}}{\text{20 Years kWh}} = ¢ / \text{kWh}$$

Final price could include additional incentives, similar to rooftop program.

NREL is developing a computer model to help utilities understand the economics of Community Solar programs and consider different program designs.

Community Solar: Regulatory Considerations

Securities Compliance

- Does the chosen program structure trigger securities issues?

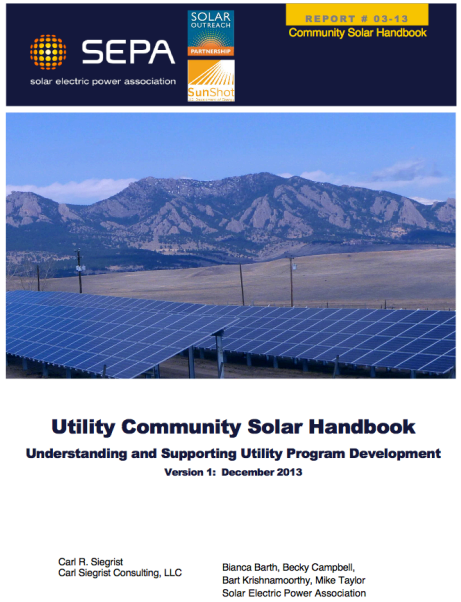
Net Metering Policy

- Does the state have net-metering?
- Does the net metering policy limit the benefits to a single customer?
- Does the net-metering policy require the solar systems to be on the customer's property? (e.g. Is virtual net metering allowed?)

Required Community Solar

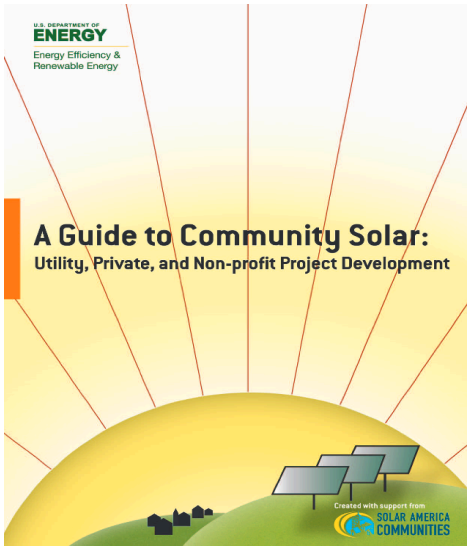
- Should utilities be required to offer community solar?
  (e.g. Colorado Community Solar Gardens Act, HB10-1342)

Community Solar: Resources

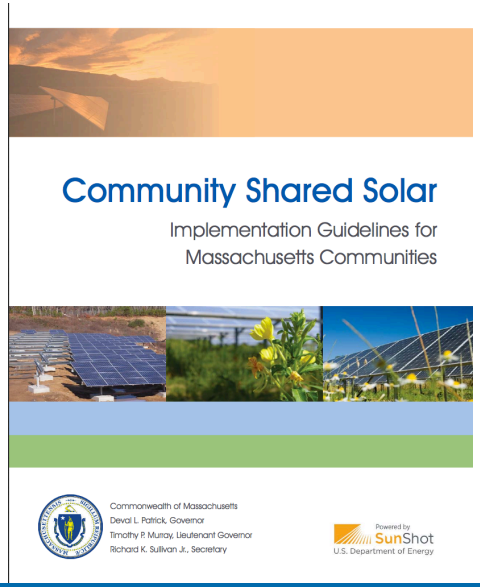


http://www.solarelectricpower.org/media/71959/solarops-community-solar-handbook.pdf

http://www.irecusa.org/wp-content/uploads/Community-Shared-Solar-Handout-final-010913.pdf



http://www.nrel.gov/docs/fy11osti/49930.pdf



http://www.mass.gov/eea/docs/doer/renewables/solar/community-shared-solar-implementation-guidelines-with-contracts-032913.pdf

Utility Ownership/Management of DG Solar

Utility-owned DG Solar

Virtual Power Plant Operator

- Utility owns and maintains DG solar systems
- Utility pays rent to building owners
- Utility earns rate of return on investments
- Utility earns revenue from sale of electricity from systems
- DG systems become another supply-side resource in the utility portfolio

- The role of the utility shifts to the management of the distribution system.
- The utility aggregates generation from many distributed units on its system, using demand-side management and smart grid technologies to help balance load and relieve congestion.
- The utility may or may not continue to participate in electricity generation, and may encourage distributed generation at beneficial locations on the system.

Utility Ownership/Management of DG Solar

Utility-owned DG Solar → ***Virtual Power Plant Operator***

Regulators can:
- Allow IOUs to recover costs of investment in DG
- Encourage IOUs to include distributed solar in capacity expansion plans

Utilities gain:
- Increased customer participation
- Experience with DG
- Ability to target locations where DG can support the grid

Regulators can:
- Allow IOUs to recover costs of investments in smart grid and other technologies that support high penetration of DG
- Restructure rates to allow utilities to gain revenue from the provision of system management

Utilities gain:
- Clearly defined role into future
- Clear revenue stream

Examples

Utility-owned DG Solar

Virtual Power Plant Operator

Duke Energy installed DG solar on offices, warehouses, schools and manufacturing facilities in North Carolina.

Duke owns the systems and pays landowners annual rental fee.

Arizona Public Service is conducting the Flagstaff Community Power Project.

APS installed and owns DG solar on homes and schools to create a high DG scenario. Utility is testing smart grid technologies and learning how to maximize system performance.

Models requiring utility subsidiaries

Utility investment in 3rd Party Leasing

- Utility invests in 3rd party solar leasing companies
- Utility provides customer connections and name recognition
- Utility owns assets and recovers investment costs and rate of return
- 3rd party provider compensated for development and maintenance
- Utility includes the DG as a supply in resource planning

Example: PG&E has tax equity financing agreements with Solar City and Sun Run.

Value Added Consulting Services

- Utilities provide customers with comprehensive energy consulting and services, including:
  - ✧ Energy efficiency
  - ✧ Distributed generation
  - ✧ Demand-side management
  - ✧ Connection with vendors
  - ✧ Coordination/site-management
  - ✧ On-bill financing
  - ✧ Energy education

Business Model Questions for Regulators

- Which business models are best suited for our State's circumstances (solar resource, market, expected level of DG)?
- Which business models best ensure recovery of system costs and equitability among ratepayers?
- What regulatory changes are needed to facilitate new utility business models?

RAP Energy solutions for a changing world

Regulatory Considerations Associated with the Expanded Adoption of Distributed Solar

Valuation and Rate Structures

Presented by: Carl Linvill

February 20, 2014

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Valuation Perspectives and Components

- Long tradition of thinking about "value" from different perspectives
- Whose costs/avoided costs/benefits?
  - PV Customer
  - Non-participating Customers
  - Utility/System
  - Society
- Analysts use different components, even for a given perspective

Five Different Valuation Perspectives

Perspective	What Constitutes "Value"
PV Customer (PCT)	Will the PV customer's costs change?
Other Customers (RIM)	Will utility *rates* change?
Utility (UCT or PACT)	Will the utility's *costs* (revenue requirement) change?
Total Resources (TRC)	Will the sum of utility costs and PV customer costs change?
Society (SCT)	Will total costs to society change?

States Using Each Test for Energy Efficiency Programs

Perspective	States Using Test	States Using as PRIMARY Test
PCT	53%	---
RIM	51%	2%
UCT/PACT	65%	12%
TRC	84%	71%
SCT	40%	15%

Source: American Council for an Energy-Efficient Economy (2012)

Major Categories of Value

Benefits	**Costs**
Energy	Direct
Line loss savings	Administrative
Generation capacity	Interconnection
T&D capacity	Integration
Fuel price hedge	Risk/opportunity cost
Risk reduction	
Environmental	
Grid security & reliability	

Terminology differs from study to study

Value of Solar Studies Differ by Perspective and Advocacy Point of View

- Two different questions to consider in parsing a study:
  - What valuation perspective is being analyzed and what components are appropriate given that perspective?
  - What advocacy point of view is being presented and how does the advocacy point of view affect which components are included?

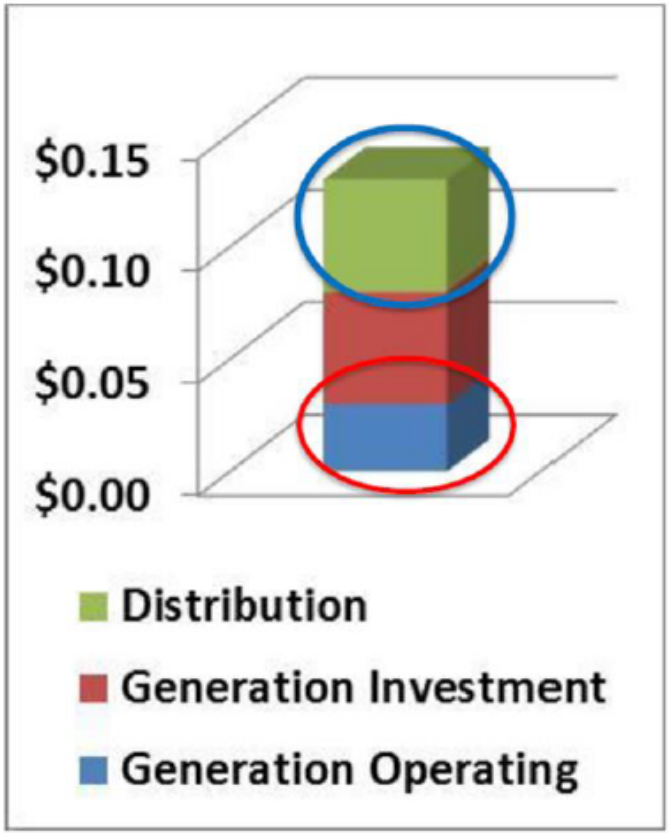
Common Utility Advocate View

Embedded Cost Perspective

- **Only the short-run avoided operating cost should be credited.**
- **At minimum, customer should pay distribution costs.**

DG customer "uses" the grid and should pay for it;

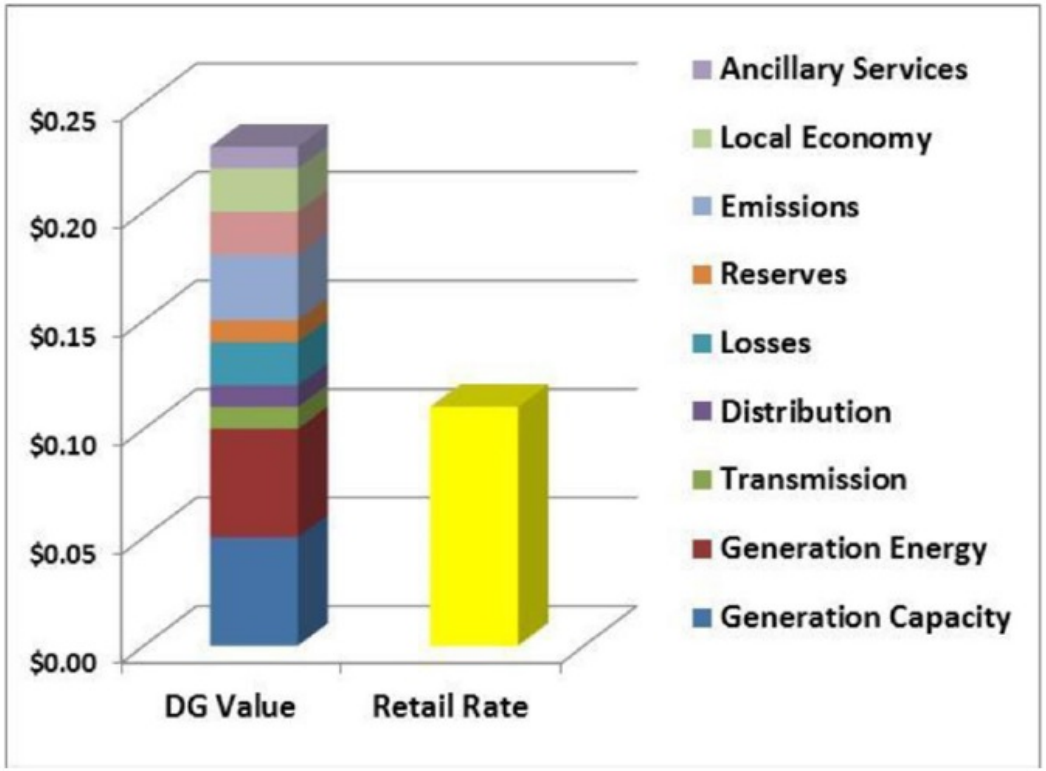
Solution: High monthly fixed charges for grid service.



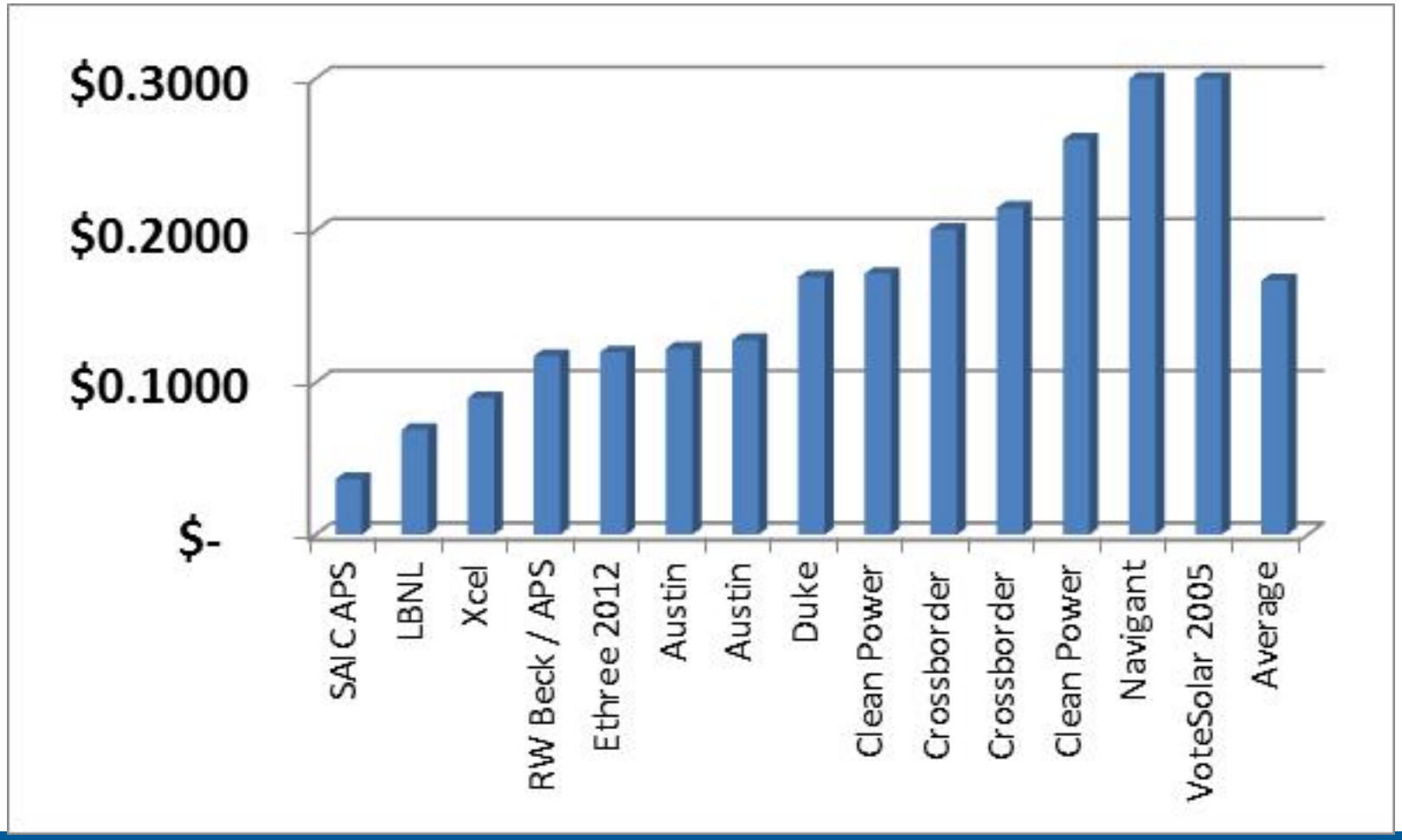
Common DG Advocacy View

Marginal Cost Perspective:

- Value of distributed resource is greater than the than retail rate;
- Net-metering results in subsidy **to** the grid from innovators.



RMI Survey Of Multiple VOS Studies
(apples & oranges average: $0.1672/kWh)



Valuation Resources

- RAP, *Full Value of Energy Efficiency*, Lazar & Colburn (September 2013)
  - http://www.raponline.org/document/download/id/6739
- Rocky Mountain Institute (RMI), *A Review of Solar PV Benefit & Cost Studies, 2nd Edition* (September 2013)
  - http://www.rmi.org/Knowledge-Center/Library/2013-13_eLab - DER Benefit Cost Deck_2nd Edition_130903
- Interstate Renewable Energy Council (IREC), *A Regulator's Guidebook: Calculating the Benefits and Costs of Distributed Solar Generation* (October 2013)
  - http://www.irecusa.org/wp-content/uploads/2013/10/IREC_Rabago_Regulators-Guidebook-to-Assessing-Benefits-and-Costs-of-DSG.pdf

Rate Design

Note: The RAP report that Carl references in this section of the webinar recoring is:

Designing Distribution Tariffs Well. By Carl Linvill, Jim Lazar and John Shenot, December 2013. Available at: http://www.raponline.org/document/download/id/6898

Typical Residential Rate Structures

Monthly Bill =

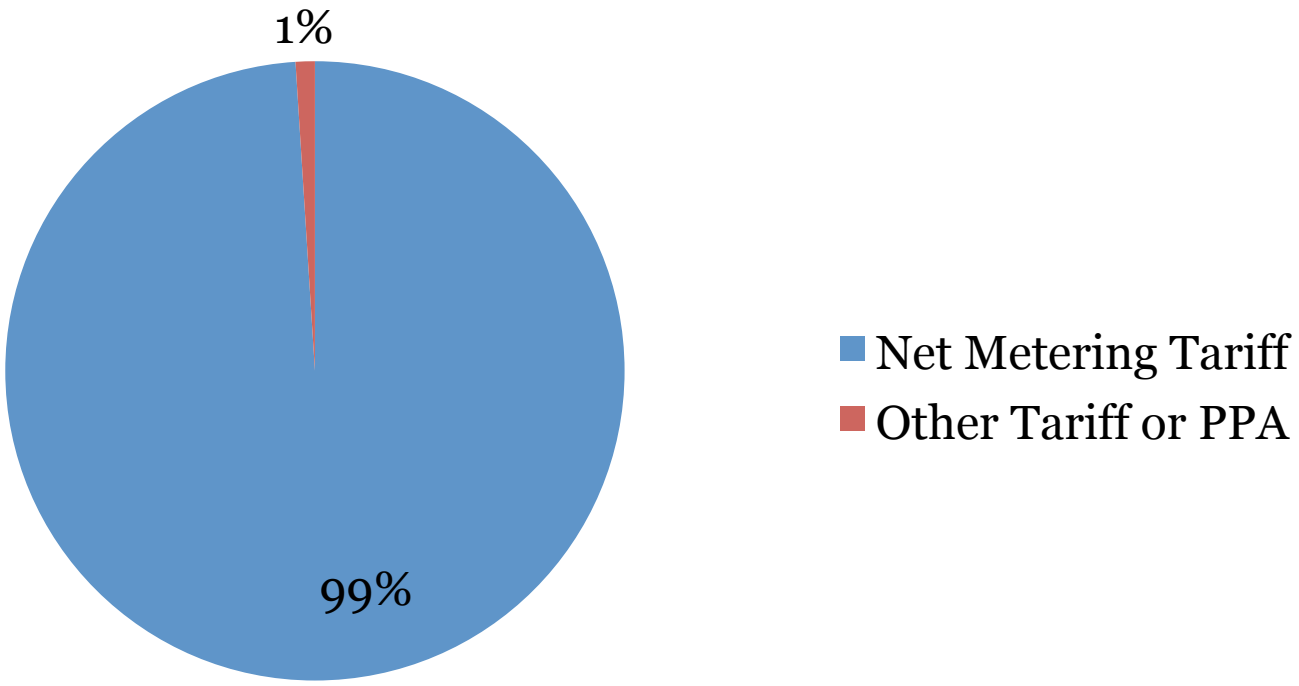
Fixed service charge (e.g. $6.75/month)

+

Volumetric charges (e.g., 8.000 cents/kWh)*

*NOTE: Volumetric charges may vary by time of day or season

Almost All PV Systems are Net Metered



Source: Solar Electric Power Association (2012)

Why is Net Metering the Dominant Tariff?

- Simplicity: possible with single meter and adaptable to many circumstances
- PURPA:
  - Utility obligation to purchase/serve
  - Federal ratemaking standard
- State laws/PUC rules or orders
- Usually best option for PV customer:
  - Compensation at retail, not wholesale, rate

Net Metering Issues under Typical Residential Rate Structures

- PV customer derives value from grid connection, and utility derives value from PV generation
- Most of the utility's fixed costs & profits for building/operating the grid are recovered through volumetric charges
- Is system value of PV generation greater than or less than volumetric charges?

Potential Cross-Subsidies

- If value of PV < volumetric charges:
  - Other customers subsidize PV customers
  - Under-recovery of utility's fixed costs
  - Upward pressure on rates (cross subsidy)
  - Reduced utility shareholder returns
- If value of PV > volumetric charges:
  - PV customers subsidize other customers
  - Suppresses PV deployment

Are potential cross-subsidies a significant problem?

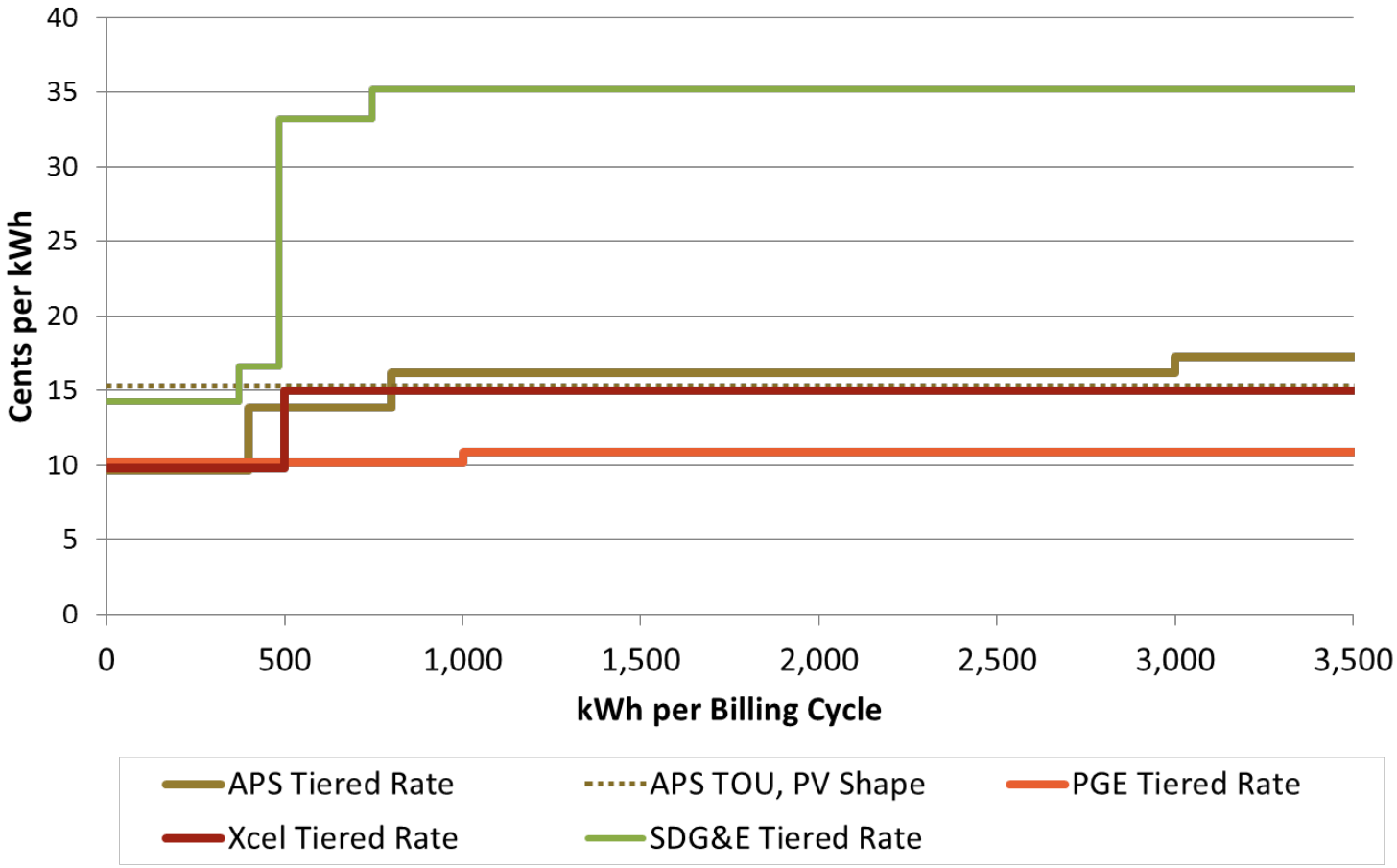
- Some level of cross-subsidy is normal
  - Customer classes, not individual rates
  - *Undue* discrimination is bad
- At low penetration levels, these lost revenues are extremely small compared to the revenue requirement
- But as deployment grows, at some point this could become a problem

Beware of extrapolating from non-representative situations …

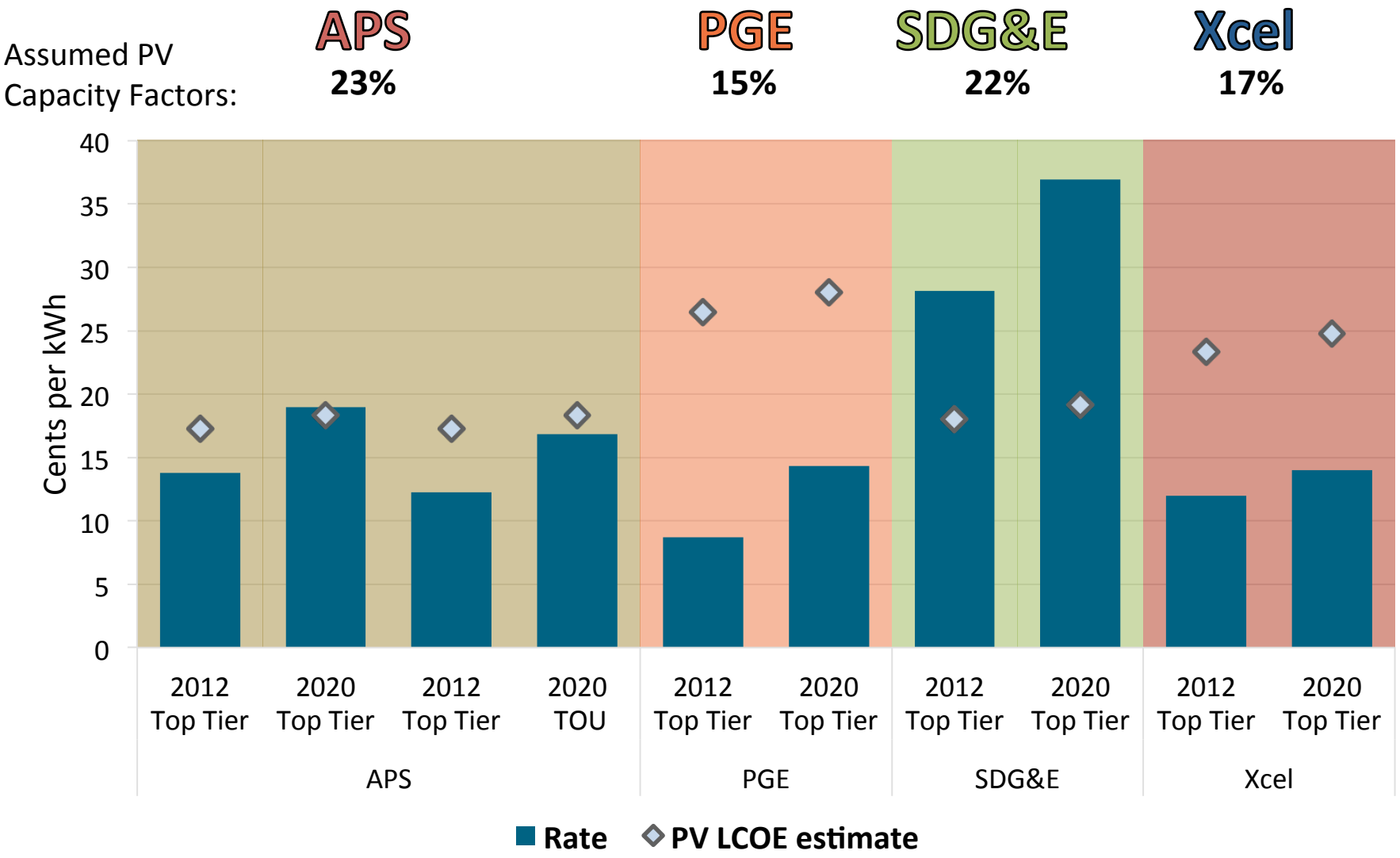
- Tail block rates are far in excess of long run marginal cost are not normal

- Low fixed and demand charges for PV adopters combined with very high tail block rates drives the high subsidy results reported in a few places

Tail Block Rates Vary (E3, 2013)



Tail blocks and value vary (E3, 2013)



Possible Alternative or Supplemental Tariff Policies

- Fixed charges
- Demand charges
- Minimum monthly bills
- Time-based rates
- Stand-by rates
- Two-way rates (i.e., value of solar)
- Separate PV customer class

Illustration of Alternative Rate Designs

Type of Charge	Unit / Usage	Typical Current Residential Tariff	Option 1 Fixed Monthly Charge	Option 2: Demand Charge	Option 3: Bidirectional Distribution Charge
Monthly Fixed Charge:	$/Month	$ 5.00	$ 35.00	$ 5.00	$ 5.00
Demand Charge	$/kW/Month		$ -	$ 3.00	$ -
Distribution Charge	$/kWh		$ -	$ -	$ 0.03
Off-Peak Energy	$/kWh	$ 0.145	$ 0.08	$ 0.08	$ 0.08
On-Peak Energy	$/kWh	$ 0.145	$ 0.15	$ 0.15	$ 0.15
Average Customer Bill					
Fixed Charge	Per Customer	$ 5.00	$ 35.00	$ 5.00	$ 5.00
Demand Charge	10 kW Demand	$ -	$ -	$ 30.00	$ -
Distribution Charge	1,000 kwh total energy	$ -	$ -	$ -	$ 30.00
Off-Peak Energy	500 kWh on-peak	$ 72.50	$ 40.00	$ 40.00	$ 40.00
On-Peak Energy	500 kWh off-peak	$ 72.50	$ 75.00	$ 75.00	$ 75.00
		$ 150.00	$ 150.00	$ 150.00	$ 150.00

Each alternative produces $150/month from a customer using 1,000 kWh/month

Breakdown of Hypothetical PV Customer Bill

Rate Element	Typical Current Residential Tariff	Option 1 Fixed Monthly Charge	Option 2: Demand Charge	Option 3: Bidirectional Distribution Charge
Fixed Charge	$ 5.00	$ 35.00	$ 5.00	$ 5.00
Demand Charge	$ -	$ -	$ 30.00	$ -
Distribution Charge	$ -	$ -	$ -	$ 30.00
Off-Peak Energy	$ 72.50	$ 40.00	$ 40.00	$ 40.00
On-Peak Energy	$ (72.50)	$ (75.00)	$ (75.00)	$ (75.00)
Total Bill:	$ 5.00			
Total Distribution Service:	$ 5.00	$ 35.00	$ 35.00	$ 35.00

Assumptions: 10 kW maximum demand; 1,000 kWh total consumption, 50% on-peak; 1,000 kWh total on-site production. 500 kWh imported from grid off-peak; 500 kwh exported to grid on-peak

High Fixed Charges can be Regressive

Type of Charge	Unit / Usage	Typical Current Residential Tariff	High Fixed Charge	Demand Charge	Bidirectional Distribution Charge
Monthly Fixed Charge:	$/Month	$ 5.00	$ 35.00	$ 5.00	$ 5.00
Demand Charge	$/kW/Month		$ -	$ 3.00	$ -
Distribution Charge	$/kWh		$ -	$ -	$ 0.03
Off-Peak Energy	$/kWh	$ 0.145	$ 0.08	$ 0.08	$ 0.08
On-Peak Energy	$/kWh	$ 0.145	$ 0.15	$ 0.15	$ 0.15

Impact on Customer Average Bills	Average User (1,000 kWh)	$ 150.00	$ 150.00	$ 150.00	$ 150.00
	Small Use (500 kWh) Bill:	$ 77.50	$ 92.50	$ 77.50	$ 77.50
	PV Customer Total Bill	$ 5.00	$ -	$ -	$ -
	PV Customer Distribution	$ 5.00	$ 35.00	$ 35.00	$ 35.00

Possible Guiding Principles for Fair PV Tariffs

- PV customer should pay utility fair value for services provided by grid connection
- Utility should pay PV customer fair value for services provided by PV
- Rate design should be no more complicated than necessary
- Address any desired incentives and the impact of lost revenues separately
- Account for low income customer impacts

Valuation and Rate Design Questions for Regulators

Valuation Questions

- What is the current and expected level of PV adoption?
- What investment will be required with and without higher PV adoption?
- Are utilities positioned to measure and capture locational benefits?
- What perspectives will be evaluated?
- What sources of cost and benefit will be included in each?

Residential Rate Design Questions

- What is the direction of the subsidy in the current DG tariff under the current residential rate design?
- What is the direction for community solar/solar garden designs?
- Should the residential tariff rate design change?
- Should the DG tariff structure change?

Non-residential Rate Design Questions

- What is the direction of the subsidy in the non-residential DG tariffs and rate designs?
- Should the non-residential tariff rate design change?
- Should the non-residential DG tariff structure change?

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QUESTIONS?

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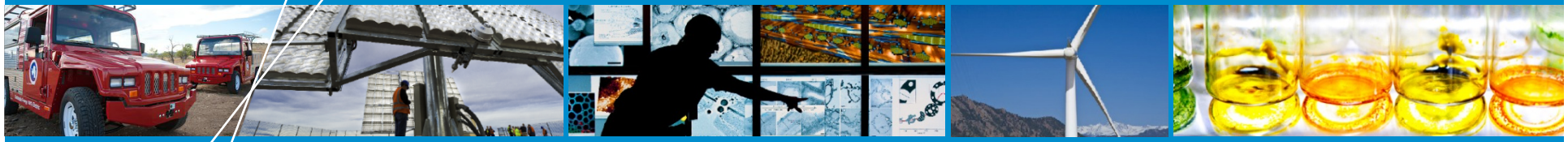

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http://www.nrel.gov/docs/fy14osti/60613.pdf